Katherine WwTP Environmental Risk Assessment

August 2022

PowerWater

Contents

Introduction

Background

The Power and Water Corporation (PWC) operate the Katherine Wastewater Treatment Plant (KWwTP) to treat and evaporate the wastewater created by the Katherine Community. The plant is located approximately 8 kilometres from town on the banks of the Katherine River. The KWwTP consists of primary screening or settling ponds followed by secondary maturation ponds. (**Figure 1**). **Figure 2** shows that site plan, monitoring locations and flow for the KWwTP.

Figure 1 Katherine waste stabilisation and evaporation ponds (PWC 2019)

The discharge of treated wastewater from the KWwTP to the Katherine River is subject to requirements specified by the Controller of Water Resources in conditions associated with Waste Discharge Licence (WDL) 151-07, issued under the *Water Act 1992* (NT), specifically authorised and managed under Condition 22 of WDL 151-07.

SLR Consulting Australia Pty Ltd (SLR) was engaged by PWC to undertake an environmental risk assessment (ERA) for discharges from the KWwTP entering the Katherine River to meet the requirement of Condition 40 of WDL 151-07 for the current reporting period 2020-2022.

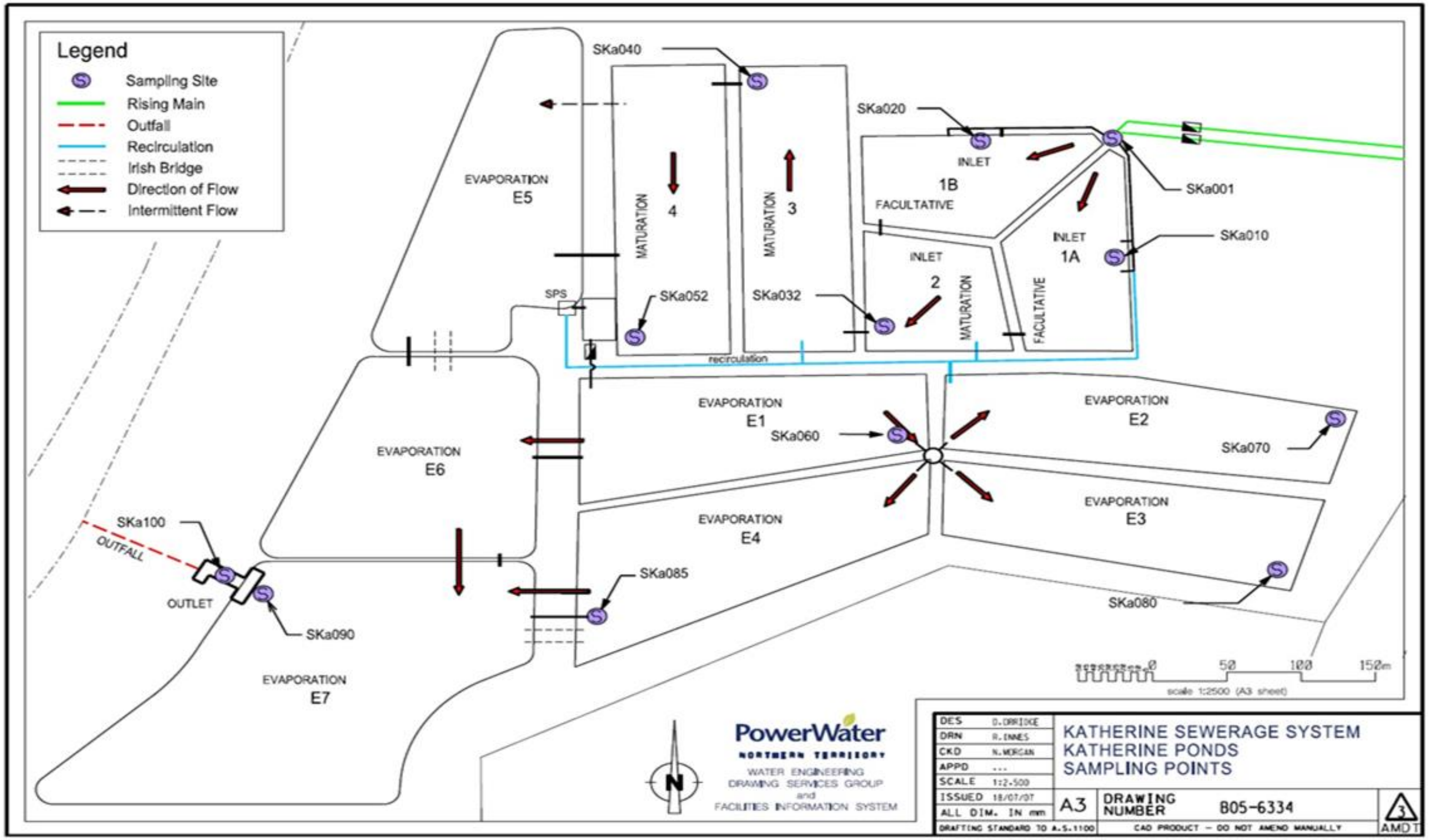

Figure 2 Site plan and flow diagram for KWwTP

Objectives

The primary objective of this ERA is to meet the requirement of Condition 40 of WDL 151-07:

"The licensee must submit to the Administering Agency by 30 November 2022, an updated Environmental Risk Assessment, informed by the data collected in the licence period."

This ERA builds on the information presented in the 2019 *Katherine Wastewater Treatment Plant Environmental Risk Assessment* (PWC, 2019) and uses the data collected during the current licence period (2020-2022) to assess the potential risks to users of the Katherine River water including its ecology.

Framework

This ERA has been undertaken in accordance with the approach and guidance recommended in the following references:

- Australian and New Zealand Governments (2018). Australian and New Zealand Guidelines for Fresh and Marine Water Quality; and
- NEPC (2013) Schedule B5a, Guideline on Ecological Risk Assessment.

Previous reports

The following reports have been reviewed to inform this assessment:

- PWC. 2019. Waste Discharge Licence 151: Katherine Wastewater Treatment Plant. Environmental Risk Assessment 2019. September 2019.
- PWC. 2021. Katherine Wastewater Treatment Plant. Waste Discharge Licence 151-07. Monitoring Report 2020-2021. October 2021.

Basis for assessment and assumptions

- SLR has not conducted a quality check on data supplied by PWC. SLR have assumed that all water quality data has been assessed for quality by PWC and supplied data have been taken on face value.
- SLR have assumed that all treated wastewater, water, sediment and microbiological samples have been sampled by qualified personnel following Australian standard procedures.

Site Description

Katherine River

The Katherine River is part of the Daly River system. The Daly River catchment is considered a region of very high ecological value and there is a wide societal attachment to its pristine beauty and conservation value (van Dam et al. 2008).

The headwaters of the Katherine River lie in the escarpment country of Arnhem Land and Nitmiluk and Kakadu National Parks to the north. The Katherine River is fed by major tributaries, the King River and Dry River to the east, Seventeen Mile Creek to the west, and Scott Creek, Mathieson Creek and the Flora River, to the south (Cooper and Jackson 2008). The Katherine River flows through Katherine from the north-east to the south-west. Approximately 40 km downstream of Katherine, the King River joins the Katherine River. The Katherine River joins the Daly River approximately 75 km downstream of Katherine (Coffey 2018).

The Katherine River consists of an incised channel, generally between 200 m and 300 m wide and 20 m deep. It has a wide, flat floodplain and the main channel is heavily vegetated. Where the Katherine River crosses the unconfined Tindall Limestone aquifer, the groundwater feeds into it through springs on both sides of the river (Coffey 2018).

The Dry Season in the Katherine area extends from April to October. Groundwater discharge from aquifers sustains Dry Season baseflows in parts of the river system within the Katherine River catchment: including the Katherine River, Flora River and the lower part of the King River.

Groundwater

Groundwater baseflows in the catchment are drawn from the Tindall Aquifer, the most substantial and reliable groundwater resource within catchment. It is a highly permeable dolomitic aquifer, with groundwater occurring in cavities and fractures. Sinkholes are a common surface feature, and act as points of recharge to, and occasionally discharge from, the aquifer. The groundwater discharge from the Tindal aquifer supports the Dry Season base flows of the Katherine River (van Dam et al. 2008).

Ecology

van Dam et al. (2008) provides a summary of ecological assets and associated key values for the Daly River catchment of which the Katherine River is a major sub-catchment (**Table 1**).

Asset	Description
Waterways	4,860 km of riverine length, representing 9 geomorphic types, dominated by confined and constrained reaches and anabranching reaches. **Additional values:** *Freshwater discharge* – dependence of estuarine/marine fisheries on river discharge *Perennial flow* – discharge from underground aquifers and springs supports strong Dry Season base flows in at least seven major rivers/creeks

Asset	Description
	Habitat for key species – important species such as pig-nosed turtle (*Vallisneria nana*) and various fish (eg. barramundi, freshwater sawfish) are dependent on riverine ecosystems *Water quality* – high, seasonally variable water quality; low ionic strength/alkalinity upstream of Daly basin (granite/sandstone aquifers), high ionic strength/alkalinity within Daly basin (limestone/dolostone aquifers)
Wetlands	Extensive, diverse and largely intact wetland complexes that are important in maintaining biodiversity, and that include 1 wetland complex of national importance **Additional values:** *Wildlife nurseries and habitat* – diversity of different wetland types provide a range of habitats and resources for different species under different conditions and at different times. *Erosion control / sediment retention* – floodplains and swamps reduce erosive power of surface runoff and trap sediments before reaching river channels *Water regulation* – the absorbent, dispersive and flow reduction characteristics of wetlands help retain water in the system and attenuate floods
Riparian vegetation	Diverse, largely intact vegetation communities that may comprise nearly 300,000 ha within the catchment; they support very high biodiversity and endemism relative to their extent, and have many important ecological and hydrological functions; vine thickets represent a particularly important riparian community **Additional values:** *Erosion control* – riparian vegetation increases bank stability and reduces flow velocity, minimising downstream sedimentation *Habitat for wildlife* – provide shade, nutrients and submerged habitat for aquatic species, and act as corridors and refuges for terrestrial and semi-aquatic species
Biodiversity	Waterbird status of the lower Daly River floodplain satisfies requirements for Ramsar listing; the Daly River supports the largest pig-nosed turtle population in Australia, and contains more species of turtle (8) than any other Australian river; 48 species of estuarine/freshwater fish, including the rare strawman (*Craterocpehlaus stramineus*)
Threatened species and conservation reserves	Numerous EPBC-listed aquatic/semi-aquatic species, including freshwater sawfish, speartooth shark, northern river shark, freshwater whipray, false water rat; other species of significance include pig-nosed turtle, 'blackmast' strawman, exquisite rainbowfish, and two plant species – *Vallisneria* and *Spirogyra*. At least 10 conservation parks and reserves are located in the catchment.
Limestone and karst habitat	Extensive groundwater aquifers characterised by surface and subterranean karstic features such as vertical shafts, losing streams, springs, dolines, caves and solution sculptured limestone rock; the karst geology is of great importance to the catchment's hydrological regime; stygofauna are present but not well characterised

Table 1 Summary of ecological assets and key values for the Daly River catchment (van Dam et al. 2008)

Beneficial uses

The *Water Act 1992* is the primary piece of legislation that governs water resource regulation and management in the Northern Territory. Under the *Water Act 1992*, beneficial uses can be declared for specific water bodies and water quality objectives are established to describe the water quality targeted to protect the relevant beneficial uses. The beneficial uses and water quality objectives (WQOs) for Katherine River and tributaries (Northern Territory Government Gazette G15, 10 April 2019) identify the following for surface water and groundwater:

- Aquaculture
- Public water supply
- Rural domestic and stock water use
- Mining activity
- Petroleum activity

Objectives

The declared water quality objectives are as described in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG, 2018).

To meet the declared objectives PWC consider that the Australian and New Zealand Freshwater and Marine Water Quality Guidelines[1] provide the best available information for assessment endpoints related to the risk of toxicants discharged to the Katherine River regardless of season. For the purposes of this risk assessment, the Katherine River is considered to be a slightly to moderately disturbed ecosystem, and guidelines selected for assessment are selected according to that level of species protection.

The ANZG (2018) guidelines for tropical lowland rivers have been selected when considering assessment endpoints related to the risk of physico-chemical stressors and nutrients in the screening level risk assessment. The ANZG (2018) guidelines are considered to be protective of declared beneficial uses except during extreme flood events that occur in the Wet Season.

No guidelines are available that are designed to be protective of the Katherine River water quality during the Wet Season when the Katherine River is in flood with respect to physico-chemical stressors or nutrients.

[1] https://www.waterquality.gov.au/guidelines/anz-fresh-marine

WDL 151-07

WDL 151-07 manages the environmental aspects of the treated discharge from the KWwTP under the *Water Act 1992*. The *Water Act 1992* defines pollution, in relation to water, as meaning to directly or indirectly alter the physical, thermal, chemical, biological or radiological properties of the water so as to render it less fit for a prescribed beneficial use for which it is or may reasonably be used, or to cause a condition which is hazardous or potentially hazardous to:

a) public health, safety or welfare;
b) animals, birds, fish or aquatic life or other organisms; or
c) plants.

WDL 151-07 imposes a number of general and specific requirements on PWC in relation to the discharge of treated wastewater from the KWwTP.

The General Conditions of WDL151-07 include the requirement that the Licensee do all things reasonable and practicable to:

- Prevent or minimise the likelihood of pollution occurring as a result of, or in connection with, the activity;
- Prevent or minimise the likelihood of environmental harm occurring as a result of, or in connection with, the activity;
- Effectively respond to pollution and the risk of pollution occurring as a result of, or in connection with, the activity;
- Effectively respond to environmental harm and the risk of environmental harm occurring as a result of, or in connection with, the activity; and
- Apply the principles of ecologically sustainable development.

Conditions within WDL 151-07 that are specifically addressed/considered in this ERA include the following:

- **Condition 22** of WDL 151-07 requires that the licensee must ensure that all discharge events at the authorised discharge point take place when the Katherine River Gauging Station, GS814-0001, is at a minimum flow of 66.78 kL/s.
- **Condition 40** of WDL 151-07 requires that the licensee must submit to the Administering Agency by 30 November 2022, an updated Environmental Risk Assessment, informed by the data collected in this licence period.

WDL 151-07 provides a surface water monitoring schedule in Appendix 2 that includes one sampling location at the discharge outlet (SKa100).

Effluent Management

PWC have constructed the KWwTP in order to prevent the discharge of untreated municipal wastewater to the Katherine River in the Dry Season. PWC uses waste stabilisation pond technology to treat the effluent to a high standard, prior to discharging it to the environment during the Wet Season when dilution is greatest and primary productivity in the Katherine River is limited by light (Robson et al. 2010). In addition, the overall volume of water to be discharged is reduced by storage and subsequent evaporation during the Dry Season. No reuse of water occurs at the Katherine WwTP.

Treated effluent from the Katherine Waste Stabilisation ponds discharges to the Katherine River directly adjacent to the treatment facility (**Figure 3**). Discharges are permitted at a flow rate of 66.78 kL/s (WDL 151-07) which is equivalent to a river height of greater than 1.67 m at Gauging Station 8140001; Katherine River Rail Bridge. The decision to cease a discharge is based on the ability to safely access the site to manually close the discharge flume and an assessment of the pond levels returning to a sustainable capacity or if the river level drops below 3 m.

At the minimum authorised discharge conditions (i.e. 66.78 kL/s) the dilution rate is approximately 1:575 for effluent to river water (PWC 2019). However, to provide a conservative safety buffer PWC uses a protocol of not discharging until the river is at a height of 3 m (138 kL/sec) and rising, resulting in a dilution of greater than 1:1,190. This river height allows the pumps from the KWwTP to run at their maximum hydraulic flow rate and minimises operator involvement.

Figure 3 Discharge pipe from KWwTP to Katherine River (PWC 2019)

Historical Risk Assessments

PWC has conducted risk assessments for the potential for adverse effects on the Katherine River from the KWwTP since 2013 (PWC 2019). **Table 2** shows the risk assessments conducted since 2013, the results of these risk assessment are summarised in this section.

Year	Type
2013	Risk assessment workshop PWC and DoH
2013-2014	Screening Level Risk Assessment AUSRIVAS Monitoring
2014-2015	Preliminary Risk Assessment
2016	Supplementary Risk Assessment Drinking water survey for pathogen risk Assessment of groundwater contamination Seepage investigation - Water balance
2017-2018	Preliminary Risk Assessment – PFAS
2017-2019	Screening Level Risk Assessment
2019	Supplementary Risk Assessment - PFAS

Table 2 History of Risk Assessments conducted by PWC

Screening Level Risk Assessment – AUSRIVAS (2014)

PWC engaged Tropical Water Solutions Pty Ltd (TWS) to perform AUSRIVAS monitoring of the Katherine River to identify if an environmental impact was occurring as a result of the discharge of treated effluent from the KWwTP. Monitoring was conducted in 2011, 2012 and 2013 Dry Seasons. Macroinvertebrate surveys provide a useful line of evidence as the results are used as an integrated assessment of impacts.

The results of the surveys showed that none of the AUSRIVAS and physico-chemical analyses detected a change in the water quality and macroinvertebrate community downstream of the WwTP discharge site when compared to upstream and also in comparison to upstream and downstream sites of a reference stream. No trend over time was detected.

Risk Assessment Summary (PWC 2019)

The information provided in PWC (2019) on all the risk assessments conducted from 2011to 2019 has been summarised in **Table 3.**

Analyte	Environmental factors	Risk
BOD	A healthy receiving water, such as the Katherine River during the Wet Season will contain between 5-7 mg/L of dissolved oxygen. The minimum discharge ratio between effluent and river water of 1:575 implies that any observed oxygen demand would be completely absorbed by the environment.	Low
Hydrocarbons	Observations performed by operators during the 2017-19 Wet Season observed no petroleum hydrocarbons in the effluent discharged to the Katherine River. There is a low likelihood of hydrocarbons being present in the discharge, as organic compounds such as hydrocarbons are degraded by the pond treatment process.	Low
Nutrients	Primary productivity in the Katherine River is driven by light, phosphorous and nitrogen in the Dry Season. However, light is limited in the Wet Season due to high turbidity and the increase in nutrients from the discharge will not increase the primary production (Robson et al. 2010).	Low
Suspended solids	Suspended solids exert an environmental effect by blocking out the sun in an environment. Robson et al. (2010) states that primary productivity in the Katherine and Daly Rivers is already limited by light in the Wet Season. This implies that the suspended solids naturally present in the ecosystem as a result of runoff already block out the light with the potential to reduce plant growth.	Low
Free ammonia	The pH of water in the Katherine River during the Wet Season is expected to be very close to neutral. At a pH of 7 the ANZG (2018) trigger value for free ammonia is 2,180 ug/L. According to this assessment, free ammonia is not likely to exert a toxic effect to the ecosystem of the Katherine River in the vicinity of the discharge pipe.	Low
Aluminium	The water discharged to the Katherine River will receive a minimum dilution ratio of 1:575 between effluent and river water. However, the KWwTP discharges occur at a dilution of 1:1,190, therefore metals are not likely to exert a toxic effect to the ecosystem of the Katherine River in the vicinity of the discharge pipe.	Low
Copper		Low
PFOS	All results meet the 95% species protection levels (HEPA 2018) and therefore considering the significant dilutions that occur on discharge the risk of environmental harm associated with the KWwTP as a PFAS source is low.	Low
PFOA		Low
Pathogens	A risk assessment workshop was conducted in May 2013 with PWC and DoH[a] to assess the level of risk that exists as a result of the KWwTP discharge containing pathogens to the Katherine River. Two scenarios were assessed:	

Analyte	Environmental factors	Risk
	1. The risk of a person becoming ill as a result of drinking water from the Katherine River when the river height is greater than 3m at G8140001 due to pathogens from catchment sources only. 2. The risk of a person becoming ill as a result of drinking water from the Katherine River when the height is greater than 3 m at G8140001 due to pathogens from catchment sources and the KWwTP.	High High
Groundwater / Seepage	PWC consider that the risks associated with seepage into the Tindall Aquifer impacting on the declared Beneficial Uses of the groundwater are rated as low as the seepage rate co-efficient indicates that the Jinduckin formation is intact below the ponds and forms an effective aquitard and there was no evidence of a direct connection to the Tindall Aquifer	Low
[a] **DoH = Department of Health**		

Table 3 Summary of risk assessment results (PWC 2019)

2022 Environmental Risk Assessment

Overview of 2022 ERA

The methodology of the environmental risk assessment conducted for the discharge from the KWwTP to the Katherine River has been discussed in the previous PWC ERA documents:

- PWC. 2019. Waste Discharge Licence 151: Katherine Wastewater Treatment Plant. Environmental Risk Assessment 2019. September 2019.
- PWC. 2021. Katherine Wastewater Treatment Plant. Waste Discharge Licence 151-07. Monitoring Report 2020-2021. October 2021.

Generally, the National Environment Protection Measure (Assessment of Site Contamination) (NEPC 2013) is used to assess environmental impacts from a discharge. This assessment applies a five phase process as shown in **Figure 4**. This approach is an iterative process that takes into account the following aspects:

1. **Problem identification**: defines the objectives of the ERA, evaluates the available data and establishes a preliminary Conceptual Site Model (CSM).
2. **Receptor identification**: identifies the species that may be at risk of exposure and evaluates the level of acceptable risk in the context of the ecological values that need to be protected.
3. **Exposure assessment**: produces an estimate of the chemical exposure that may be experienced by the identified ecological receptors.
4. **Toxicity assessment**: estimates the concentration of identified contaminants of potential concern (CoPCs) that an ecosystem can be exposed to without adversely affecting the ecological values.
5. **Risk characterisation**: evaluates the lines of evidence gathered throughout the ERA to estimate the potential risks posed by CoPCs to the identified ecological receptors. Determines if the risk of harm is low and acceptable or higher.

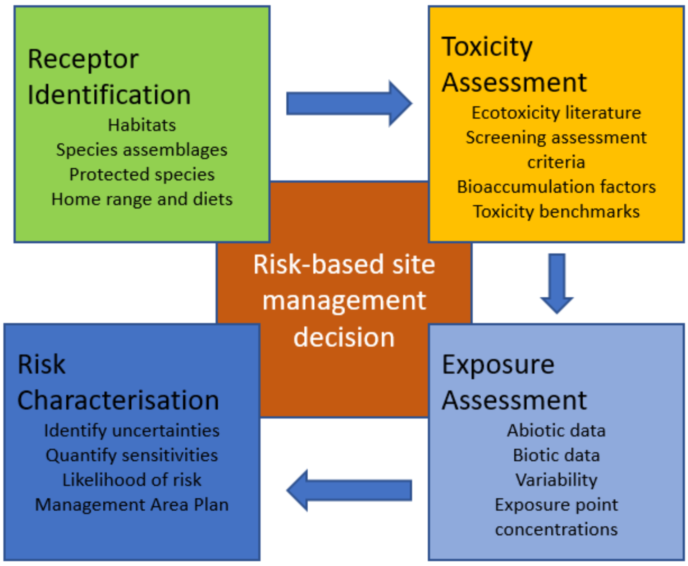

Figure 4 Ecological Risk Assessment Process

ERA Process for KWwTP

The five phases have been adopted in previous PWC ERAs for the KWwTP discharge and will not be detailed here. The 2020/21 and 2021/22 Wet Season discharge quality data has been used to determine if any of the analytes are present in concentrations are elevated when compared to previous years and if those concentrations would pose a risk to the receiving environment. If the concentrations are within the range of previous discharges, then the risks identified in **Table 3Error! Reference source not found.** are applicable t o the 2021/22 discharge.

Discharge quality 2021-2022

Table 4 shows the dates and volumes discharged from the KWwTP through SKa100 to the Katherine River during the Wet Seasons 2020/21 and 2021/22. **Figure 5** shows the discharge volumes from the KWwTP entering the Kathrine River during the Wet Seasons since 2011. Note that there were no discharges during the 2018/19 and 2019/20 Wet Seasons. **Figure 6** shows the flow in the Katherine River during the January 2022 KWwTP discharge.

Year	Discharge dates	Discharge volume (ML)
2019	No discharge	0
2020	No discharge	0
2021	27/01/2021 – 01/02/2021 17/02/2021 – 01/03/2021	191.582
2022	17-21 January 2022	43.365

Table 4 Discharge dates (2019-2022)

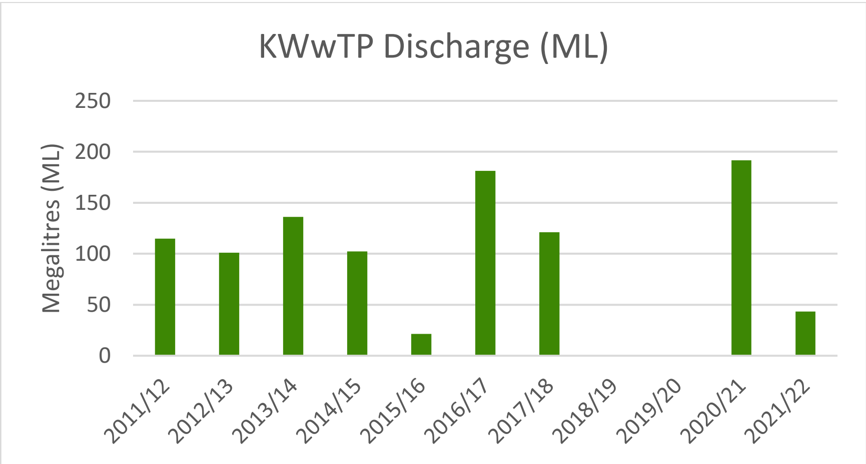

Figure 5 KWwTP annual discharge to Katherine River 2012-2022

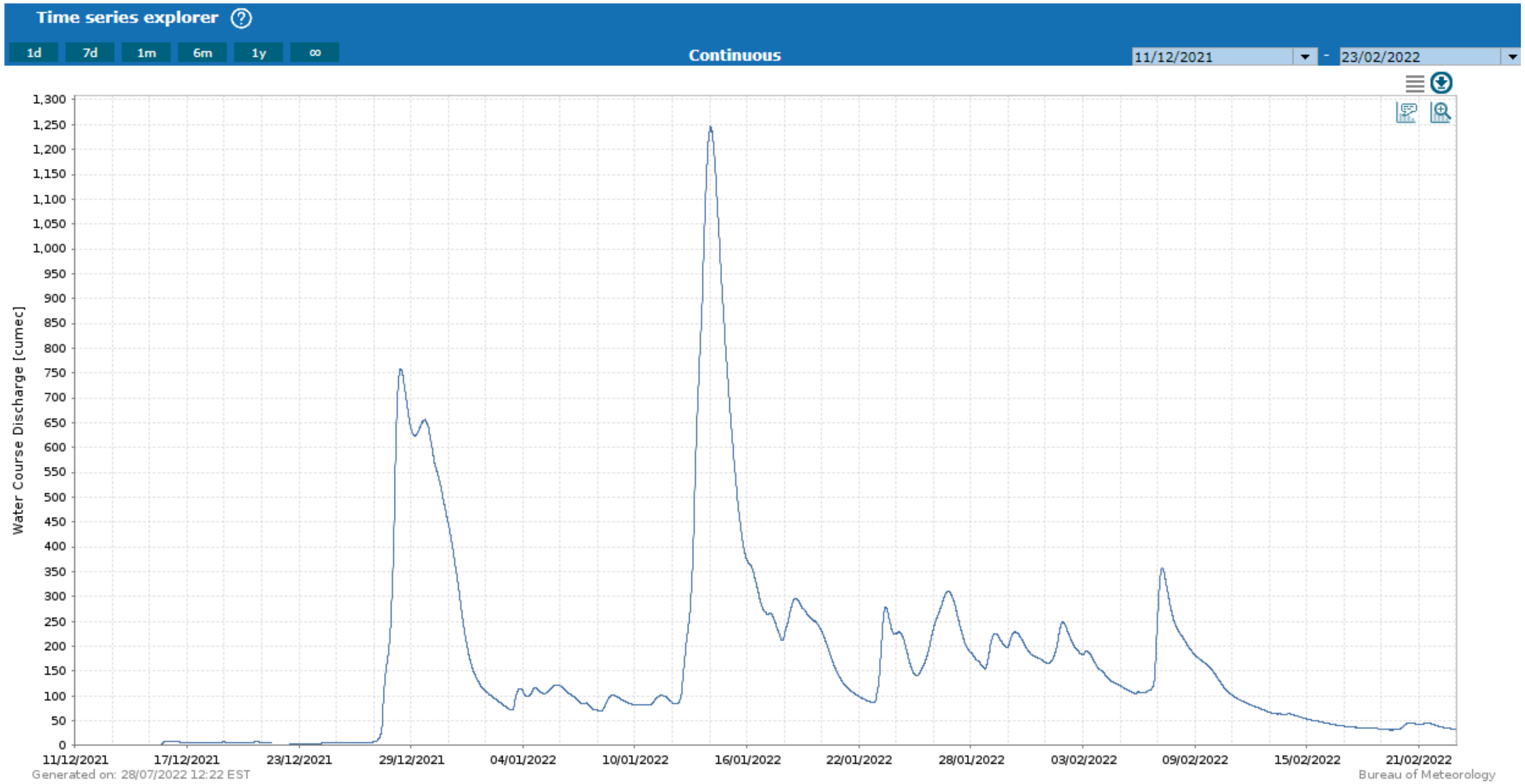

Figure 6 Katherine River during KWwTP Discharge January 2022 (cumecs)

Treated effluent discharged from the KWwTP to the Katherine River in Wet Seasons since 2011 has no gross pollutants, a moderately high nutrient content, a high turbidity and a green colour. Typically, the effluent does not generate odours, as the biodegradable carbon has been stabilised and transformed into algae, which results in the green colour. The 2021-2022 effluent quality is shown in **Table 5**.

Analyte	Guidelines[2]	Median 2011-2021	01/02/2021	23/02/2021	18/01/2022	Potential Risk
Field characteristics						
pH (pH units)	6-8	9.2	9.4	9.2	9.4	Yes
EC (µS/cm)	250	387	387	266	410	Yes
DO (%)	80-120	91	53	128	-	Yes
Temp (°C)	-	29	30	28	31	-
Nutrients (mg/L)						
FRP	4	0.9	1.6	0.7	1.8	No
TP	10	2.3	4.2	2.3	3.1	No
Total ammonia	10	0.5	0.4	0.9	0.7	No
Nitrate	-	0.1	<0.1	<0.1	<0.1	-
Nitrite	-	0.1	<0.1	<0.1	<0.1	-
NOx	5	0.05	<0.1	<0.1	<0.1	No
TN	200-300	12	26	9.5	No data	No
Environmental indicators (mg/L)						
BOD	Presence	50	47	14	26	Yes
COD	-	200	210	140	220	-
SS	2-15	111	98	90	90	Yes

[2] ANZG (2018) 95% species protection values

Analyte	**Guidelines[2]**	Median 2011-2021	**01/02/2021**	**23/02/2021**	**18/01/2022**	**Potential Risk**
VSS	-	102	92	86	82	-
Hardness as $CaCO_3$	-	72	58	41	52	-
Bacteriological indicators (MPN/100 mL)						
E. coli	200	10	<100	<100	<10	No
Enterococci	41-200	1,664	<10	86	327	Yes
[a]Total metals (µg/mL)						
Aluminium	55	-	No data	No data	80	Yes
Arsenic	13	0.5	<0.5	<0.5	<0.5	No
Cadmium	0.2	0.2	<0.2	<0.2	<0.2	No
Chromium	1	2.6	<5[b]	<5	<5	Yes
Copper	1.4	7.5	20	10	<10	Yes
Lead	3.4	1	2	1	<1	No
Mercury	0.06	0.06	0.8	0.1	0.5	Yes
Nickel	11	1.8	2	2	<2	No
Zinc	8	0.5	20	10	10	Yes
[a]The ANZG (2018) 95% species protection values for metals apply to dissolved metals, not to totals. By applying the guidelines to total metals the potential risk is overestimated. [b] The limit of detection is above the guideline value. The limit of detection is determined by the sample matrix.						

Table 5 Discharge quality SKa100 2019-2022

The discharge quality from the KWwTP was assessed for Wet Seasons 20202/21 and 2021/22. This data was compared with guideline values (ANZG 2018[3]) and the median values for data from 2011-2021 (PWC 2021). Values that were higher than the guideline or median were determined to have a potential risk of adverse impacts to the environment. In general, the 2021 and 2022 results were similar to those from the median results, with the exception of mercury. In the 2021 and 2022 discharge the mercury concentration was

[3] The ANZG (2018) apply to the receiving water not to discharges. These guidelines are lists to indicate potential contaminants of concern and further investigation.

elevated when compared to the historical median and the guideline. However, the risk of environmental harm from this concentration of mercury has been designated as low due to the high dilution within the river.

PFAS in the Katherine area (PWC 2019)

The Northern Territory Government has a structured, risk-based assessment program to evaluate PFAS risks based on addressing issues of high public health risks as the first priority, within this framework the NT Government's investigations have focused on drinking water sources and high priority sources including defence facilities and airports. RAAF Base Tindal is located in the upper catchment of the Katherine Groundwater Protection Zone and is a confirmed source of groundwater contamination, compromising the declared Beneficial Uses of both surface and groundwater in the Katherine Region and warning signs were erected in December 2017 advising against consumption of fish collected from the river. Subsequently the DoH published a fact sheet[4] that recommends to limit consumption of fish from the Katherine River between Donkey Cam Weir and the Daly River and to avoid consuming fish caught in Tindal Creek. The DoH also published a fact sheet[5] on the consumption of bushfoods in the Katherine area to assist in the understanding of the frequency and amount of bush foods that can be consumed.

PWC have assumed that the source of PFAS in the KWwTP discharge is from the Tindal aquifer that was historically used as a drinking water source for the Katherine community. Currently the drinking water supply for the Katherine area is provided by a water treatment plant designed to remove PFAS from the groundwater source. **Table 6** shows the PFAS concentrations in the KWwTP since 2017. As the source of PFAS was removed in 2018 with the commissioning of the water treatment plant, the amount of PFAS entering the KWwTP has significantly reduced (**Figure 7**), therefore the concentration of PFAS discharged from the KWwTP also showed a reduction[6] (**Figure 8**).

Date and site	PFOS (µg/mL)	PFHxS (µg/mL)	Sum PFOX + PFHxS (µg/mL)	PFOA (µg/mL)
95% Guideline[1]	0.13	0.13	0.13	220
2017 Influent (SKa001)	0.014	0.018	0.032	0.0023
2017 Effluent (SKa100)	0.016	0.015	0.031	0.0047
2018 Influent (SKa001)	<0.001	<0.001	<0.001	<0.001
2018 Effluent (SKa100)	0.055	0.030	0.085	0.005
2021 Influent (SKa001)	<0.001	0.004	0.004	<0.001
2021 Effluent (SKa090)	0.011	0.003	0.014	0.006

[4] https://ntepa.nt.gov.au/__data/assets/pdf_file/0008/570779/fishing_in_katherine_fact_sheet.pdf
[5] https://nt.gov.au/__data/assets/pdf_file/0005/596471/bushfood-in-katherine.pdf
[6] PFAS concentrations in effluent can be higher than that in the influent as precursors will be present in the system. (Thompson et al. 2011)

Date and site	PFOS (µg/mL)	PFHxS (µg/mL)	Sum PFOX + PFHxS (µg/mL)	PFOA (µg/mL)
2022 Effluent (SKa100)	0.007	<0.001	0.007	0.002
[1]HEPA (2020) Note: The PFOS guideline also applies to the PFOS+PFHxS concentration as there are no guidelines for PFHxS, it is assumed that both compounds have a similar toxicological effect.				

Table 6 PFAS concentrations in the KWwTP discharge (PWC 2019)

PWC (2019) stated that the PFAS concentrations in the KWwTP discharge poses a low risk to the protection of the beneficial uses. As concentrations in the discharge are decreasing and expected to further decrease this statement is supported.

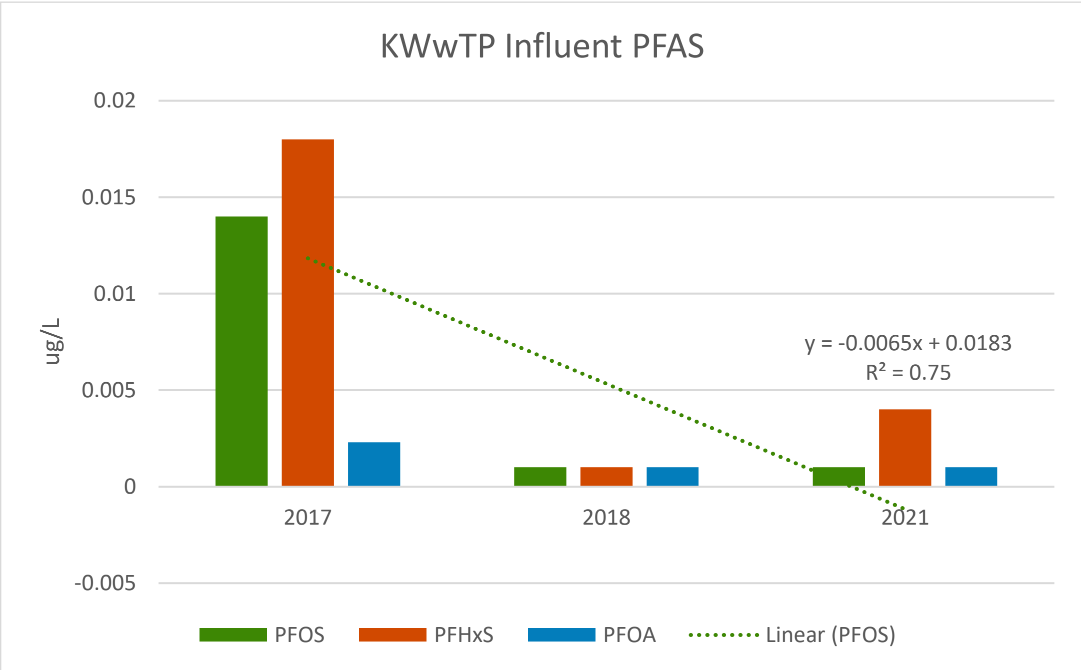

Figure 7 PFAS Concentrations in KWwTP Influent

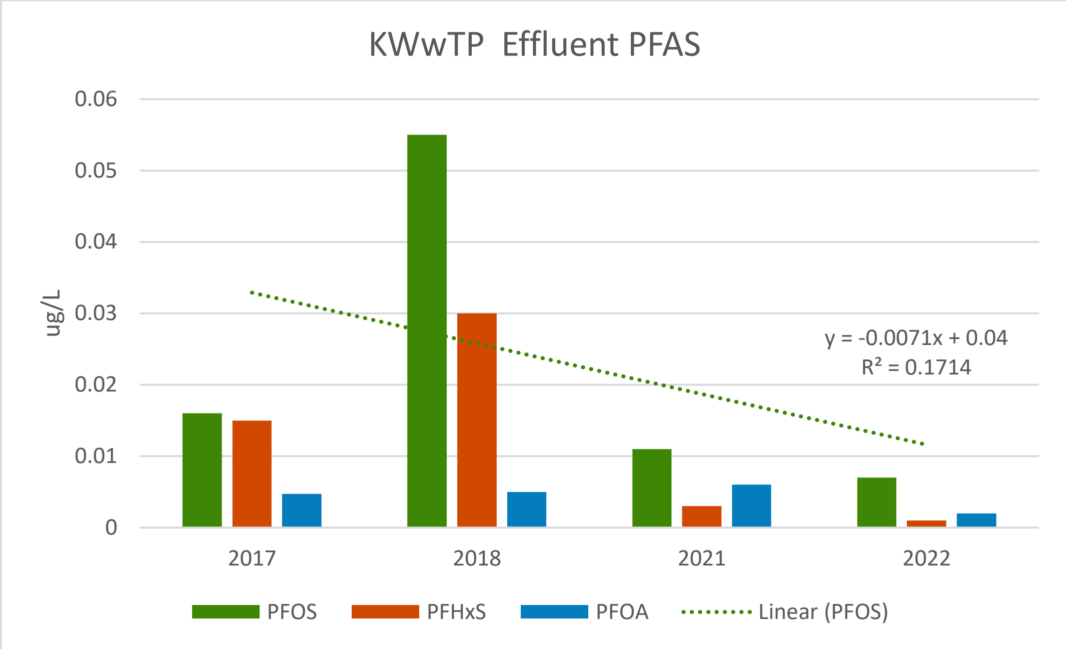

Figure 8 PFAS Concentration in KWwTP Effluent

Risk Characterisation 2021 - 2022

Table 7 shows the risk characterisation for the analytes identified in **Table 5** from the 2021 and 2022 discharge as having potential to cause adverse harm to the receiving environment. Many of the analytes have been assessed previously (PWC 2019).

Analyte	Environmental factors	Risk
Physico-chemistry	pH and EC were elevated in the discharge when compared to guidelines. However, the minimum discharge ratio between effluent and river water of 1:575 implies that any observed high pH or EC would be completely absorbed by the environment.	Low
BOD and DO	A healthy receiving water, such as the Katherine River during the Wet Season will contain between 5-7 mg/L of dissolved oxygen. The minimum discharge ratio between effluent and river water of 1:575 implies that any observed oxygen demand or low DO would be completely absorbed by the environment.	Low
Suspended solids	Suspended solids exert an environmental effect by blocking out the sun in an environment. Robson et al. (2010) states that primary productivity in the Katherine and Daly Rivers is already limited by light in the Wet Season. This implies that the suspended solids naturally present in the ecosystem as a result of runoff already block out the light with the potential to reduce plant growth.	Low

Analyte	Environmental factors	Risk
Aluminium	The water discharged to the Katherine River will receive a minimum dilution ratio of 1:575 between effluent and river water. However, the KWwTP discharges occur at a dilution of 1:1,190, therefore metals are not likely to exert a toxic effect to the ecosystem of the Katherine River in the vicinity of the discharge pipe.	Low
Chromium		
Copper		
Mercury		
Zinc		
PFOS	All results meet the 95% species protection levels (HEPA 2018) and therefore considering the significant dilutions that occur on discharge the risk of environmental harm associated with the KWwTP as a PFAS source is low.	Low
PFOA		Low
Pathogens	A risk assessment workshop was conducted in May 2013 with PWC and DoH[a] to assess the level of risk that exists as a result of the KWwTP discharge containing pathogens to the Katherine River. Two scenarios were assessed: 1. The risk of a person becoming ill as a result of drinking water from the Katherine River when the river height is greater than 3m at G8140001 due to pathogens from catchment sources only. 2. The risk of a person becoming ill as a result of drinking water from the Katherine River when the height is greater than 3 m at G8140001 due to pathogens from catchment sources <u>and</u> the KWwTP. The PWC determined that catchment sources of pathogens reduced the quality of the Katherine River in the Wet Season to a point where it was unsafe to drink. As a result, it was judged that any addition of pathogens from the KWwTP would not materially increase the likelihood of illness as a result of drinking water from the Katherine River in the Wet Season. The PWC has erected signs stating that untreated water should not be used for drinking.	High High
[a] DoH = Department of Health		

Table 7 Risk Characterisation for KWwTP 2021-2022

Table 7 shows that the risk of adverse harm to the environment for analytes exceeding the ANZG (2018) guidelines for the 2021 and 2022 discharges has not changed from the previous assessment conducted in 2019. Therefore, no additional assessment is required as the discharge quality has not demonstrably changed and the risk to the downstream environment and users also has not changed.

Conceptual site model

The PWC (2019) Environmental Risk Assessment showed a preliminary conceptual site model (CSM). This model has been updated based on the results summarised in Table 8**.** The CSM has been updated and is shown as **Figure 9**.

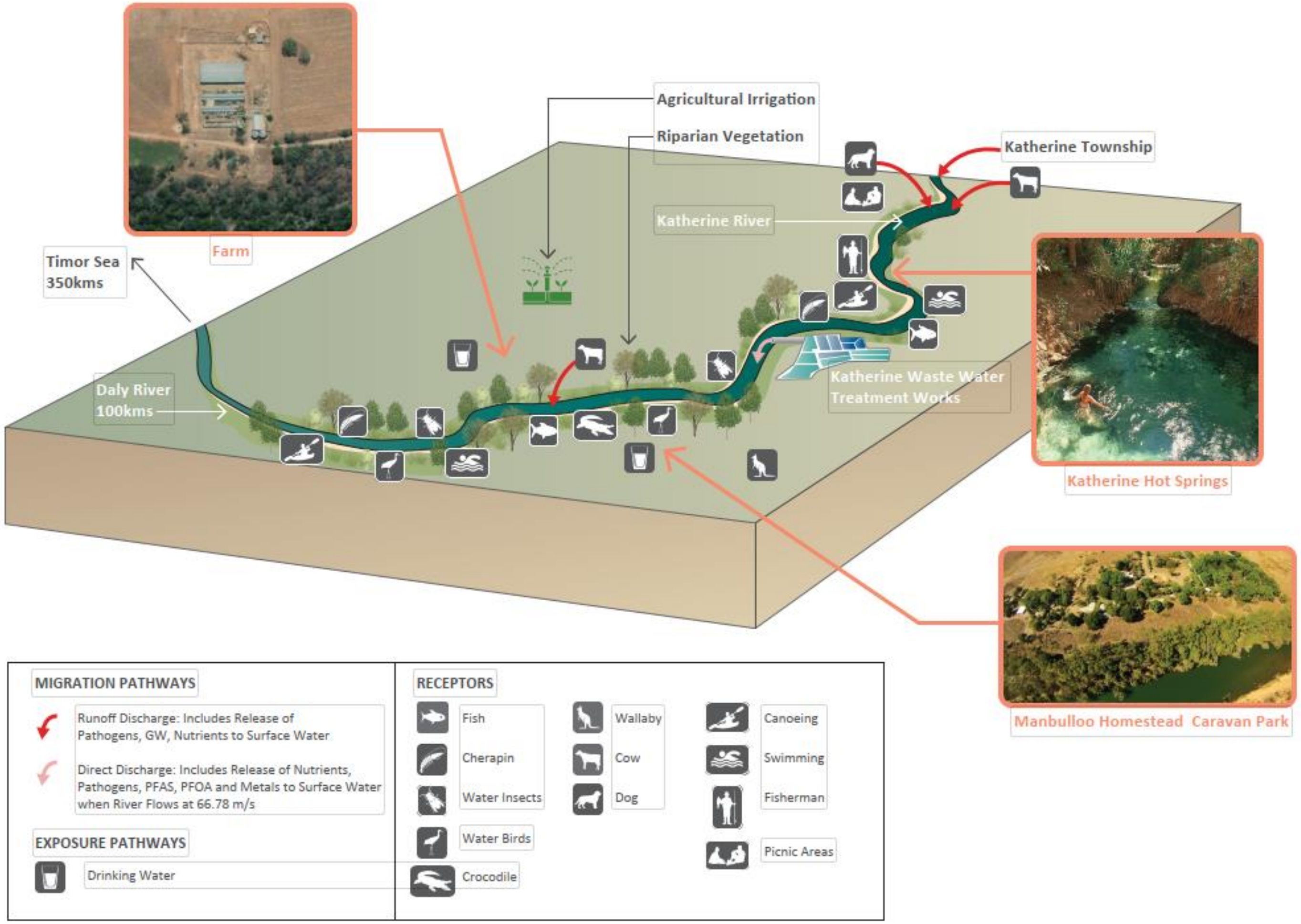

Figure 9 Katherine WwTP Discharge Conceptual Site Model

Conclusions

The environmental risk assessments conducted by PWC since 2011 have shown that the risk to the ecology and users of the Katherine River from the discharge from the KWwTP is low. The risk of exposure to pathogens for users drinking untreated water from the Katherine River during the Wet Season is high, but the risk does not increase with the addition of the KWwTP discharge. **Table 8** shows a summary of the environmental risks to the Katherine River from the KWwTP discharge.

Aspect	Risk Ranking	Further investigation
Nutrients	Low	No
Metals	Low	No
PFAS	Low	Monitoring
Pathogens	High[1]	No
Hydrocarbons	Low	No
Groundwater	Low	No

[1] Due to the high catchment input of pathogens to the Katherine River during the Wet Season, the KWwTP discharge does not increase the risk of drinking untreated Katherine River water in the Wet Season. Signs have been erected stating that untreated water should not be used for drinking.

Table 8 Summary of Risks

PWC (2019) determined that the risk of adverse harm from exposure of PFAS entering the Katherine River from the KWwTP discharge was low. Current PFAS data from the influent and discharge confirms this conclusion as the PFAS concentrations in the influent and effluent are decreasing. As the Katherine drinking water is now treated to remove PFAS, it is expected that the PFAS entering the KWwTP will continue to be reduced, thus also reducing the concentration in the discharge and maintaining a low risk to the environment.

Recommendations

Based on the results of this ERA, the following are recommended:

- Removal of the requirement for an environmental risk assessment from the WDL. All issues identified in workshops conducted with the PWC and stakeholders have been addressed and the discharge from the KWwTP has been determined to pose a low risk to the Katherine River ecology and users. Future management of the KWwTP discharge should be based on monitoring. If there are significant decreases in quality, then an ERA can be implemented to determine the impact of the poor discharge quality.
- Continue to conduct PFAS monitoring to confirm that the concentrations of PFAS in the discharge from the KWwTP are decreasing since the implementation of filtered drinking water.

References

ANZG. 2018. https://www.waterquality.gov.au/guidelines/anz-fresh-marine

Coffey. 2018. RAAF Base Tindal Ecological Risk Assessment. Department of Defence. November 2018.

Cooper D. and Jackson S. 2008. Preliminary study on indigenous water values and interests in the Katherine region of the Northern Territory. CSIRO Sustainable Ecosystems. Darwin, Northern Territory. March 2008.

HEPA (2020) National Environmental Management Plan for PFAS V2.0: Heads of EPAs Australia and New Zealand.

National Environment Protection Council (NEPC). 2013. National Environment Protection Measure (Assessment of site Contamination) Schedule B 5a Guidelines on Ecological Risk Assessment.

PWC. 2019. Waste Discharge Licence 151: Katherine Wastewater Treatment Plant. Environmental Risk Assessment 2019. September 2019.

PWC. 2021. Katherine Wastewater Treatment Plant. Waste Discharge Licence 151-07. Monitoring Report 2020-2021. October 2021.

Robson, B.J., Schult, J., Smith, J., Webster, I., Burford, M., Revill, A., Townsend, S., Haese, R. and Holdsworth, D. (2010) Towards understanding the impacts of land management on productivity in the Daly River. Charles Darwin University, Darwin.

Thompson, J., Eaglesham, G., Reungoat, J., Poussade, Y., Bartkow, M., Lawrence, M., Mueller, J.: Removal of PFOS, PFOA and other perfluoralkyl acids in water reclamation plants in South-East Queensland Australia. (2011). Chemosphere 82 (211) 9-17

Van Dam R., Bartolo R. and Bayliss P. 2008. Identification of ecological assets, pressures and threats. Chapter 2. Ecological Risk Assessments for Australia’s Northern Tropical Rivers. Environmental Research Institute of the Supervising Scientist. A Report to Land and Water Australia. https://www.dcceew.gov.au/science-research/supervising-scientist/publications/tropical-rivers/ecological-risk-assessments-australias-northern-tropical-rivers

Contact

Name – Michael Gallagher

Water Services

Michael.gallagher@powerwater.com.au

powerwater.com.au

PowerWater